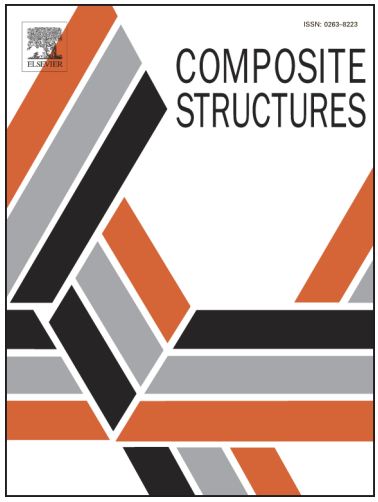

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PII: S0263-8223(16)30771-1
DOI: http://dx.doi.org/10.1016/j.compstruct.2016.05.104
Reference: COST 7517

To appear in: *Composite Structures*

Received Date: 22 February 2016
Revised Date: 25 April 2016
Accepted Date: 31 May 2016

Please cite this article as: Wang, K.F., Wang, B.L., An analytical model for nanoscale unimorph piezoelectric energy harvesters with flexoelectric effect, *Composite Structures* (2016), doi: http://dx.doi.org/10.1016/j.compstruct.2016.05.104

An analytical model for nanoscale unimorph piezoelectric energy harvesters with flexoelectric effect

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Abstract: Harvesting mechanical vibration energy in the surrounding medium is an attractive way to provide sources for self-powered micro and nano devices. At nanoscale, the properties of materials exhibit strong scaling with size. In this paper, an analytical model incorporating flexoelectric effect is developed for nanoscale unimorph piezoelectric energy harvesters with arbitrary length and position of piezoelectric layer and proof mass. The governing equation is derived based on the Hamiltonian principle. Approximated closed-form solutions for voltage out, power output and optimal load resistance are obtained. Results show that the influence of flexoelectric effect on voltage output and power output is significant, for small thickness of piezoelectric layer. In some cases, the maximum power output of the model with flexoelectric effect is almost twelve times that of classical model which only includes piezoelectric effect. Attaching the piezoelectric layer on the clamped end of the beam can get the largest power output. To obtain higher power output and conversion efficiency, especially to fit the vibration environment, attached proof mass on the end of cantilever energy harvesters is a useful way.

Keywords: energy harvesting; laminated piezoelectric nanobeams; flexoelectric effect; piezoelectricity; voltage output.